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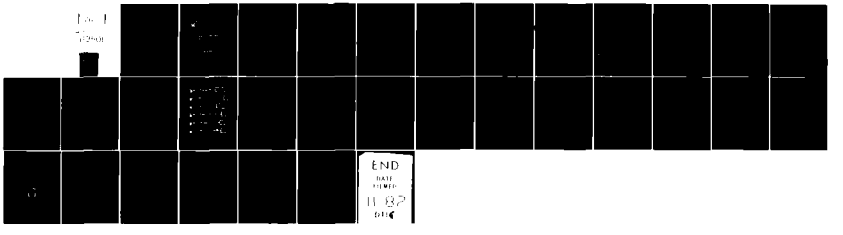

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Basic criteria for cargo handling is presented for use by experienced engineers. The contents cover considerations for the handling of cargo between vessel and dock, vessel and shore, and for the handling of cargo in pier sheds.

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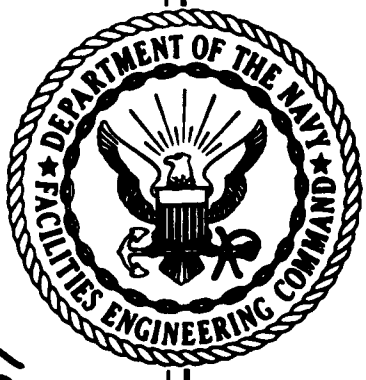

CARGO HANDLING FACILITIES

DESIGN MANUAL 25.3

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ABSTRACT

Basic criteria for cargo handling is presented for use by experienced engineers. The contents cover considerations for the handling of cargo between vessel and dock, vessel and shore, and for the handling of cargo in pier sheds.

FOREWORD

This design manual is one of a series developed from an evaluation of facilities in the shore establishment, from surveys of the availability of new materials and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command, other Government agencies, and the private sector. This manual uses, to the maximum extent feasible, national professional society, association, and institute standards in accordance with NAVFACENGCOM policy. Deviations from these criteria should not be made without prior approval of NAVFACENGCOM Headquarters (Code 04).

Design cannot remain static any more than can the naval functions it serves or the technologies it uses. Accordingly, recommendations for improvement are encouraged from within the Navy and from the private sector and should be furnished to NAVFACENGCOM Headquarters (Code 04). As the design manuals are revised, they are being restructured. A chapter or a combination of chapters will be issued as a separate design manual for ready reference to specific criteria.

This publication is certified as an official publication of the Naval Facilities Engineering Command and has been reviewed and approved in accordance with the SECNAVINST 5600.16.

W. M. Zobel
Rear Admiral, CEC, U. S. Navy
Commander
Naval Facilities Engineering Command

WATERFRONT DESIGN MANUALS

DM No.	Superseded Chapters in Basic DM-25	Title
25.1	1 and 2	Piers and Wharves
25.2	3	Dockside Utilities for Ship Service
25.3	4	Cargo Handling Facilities
25.4	5	Seawalls, Bulkheads, and Quaywalls
25.5	6	Ferry Terminals and Small Craft Berthing Facilities
25.6	7	General Criteria for Waterfront Construction

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CARGO HANDLING FACILITIES

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ACKNOWLEDGEMENTS

Marine Cargo Operations, Saubrier, Charles L., furnished data for Figures 1, 3, and 4.

Port Planning, Design and Construction, The American Association of Port Authorities, furnished data for Figure 2.

CARGO HANDLING FACILITIES

Section 1. SCOPE AND RELATED CRITERIA

1. SCOPE. This manual covers handling facilities and operations for the transfer of cargo from vessel to piers and wharves and from vessel to shore, and vice versa, and for the handling of cargo in pier sheds.

2. CANCELLATION. This publication, Cargo Handling Facilities, NAVFAC DM-25.3, cancels and supersedes Chapter 4 of Waterfront Operational Facilities, NAVFAC DM-25 (October 1971), and any of the following changes which relate to Chapter 4, Change 1 dated February 1972, Change 3 dated July 1973, Change 5 dated March 1974, Change 6 dated August 1974 and Change 7 dated June 1975. Changes 2 and 4 are cancelled items.

3. RELATED CRITERIA. For related criteria, refer to NAVFAC sources itemized below.

Subject	Source
Piers and Wharves. Mobile cranes, container cranes, and forklifts	NAVFAC DM-25.1
Weight Handling Equipment and Service Craft. Characteristics and selection factors for cranes	NAVFAC DM-38
Pontoon Gear Handbook. Pontoon structures	P-401

4. INTRODUCTION. Movement of cargo requires the basic material handling equipment necessary to load and discharge vessels. For planning ship-to-shore transfer of cargo, various factors such as working conditions, commodities, and materials to be handled must be considered. In general, determination of appropriate handling equipment shall consider:

a. The various commodities and materials to be handled.

b. The operations and processes and their sequencing.

c. The work load.

Section 2. GENERAL CARGO FACILITIES

1. SHIPBOARD EQUIPMENT. Where vessels are berthed at piers or wharves, direct transfer of cargo between docks and vessels may be made by using ship's gear either alone or in conjunction with dock-mounted equipment. Typical examples of transfer gear include the following:

a. Conventional Burtoning Gear. (See Figure 1.) This system consists of a pair of ship's booms, each stepped at the foot of a kingpost, so that one boom is fixed over the ship's hatch and the other over the pier. Cargo falls, used to lift cargo, run either by hydraulic, electric, or steam-operated winches, and pass through the boom head by means of fairleads (heel blocks, lizards, and head blocks). They are then married together at a common point above the cargo hook. Modifications of this gear are possible to meet special conditions. For maximum gear capacity, double up the system to use as a single boom. The capacity of burtoning tackle is generally two to three tons and occasionally five tons. Also, see Marine Cargo Operations, Chapter 6.

(1) Advantages. Relatively simple in design, and entails economical fuel costs, relatively simple maintenance requirements and eliminates the need for higly skilled operators.

(2) Disadvantages. Requires maximum load limitation, lacks flexibility (fixed booms are deficient in spotting abilities), entails time loss on respotting and doubling up to achieve maximum capacity, dangers involved in rigging the gear, and limited over-the-side reach.

b. Farrel Rig. This system is similar to the conventional burtoning gear except that the working guys are made fast to vang posts that are erected on deck. There are no midship guys, and the topping lift lead block assumes a position at or near the vessel's centerline. Efficiency is improved by providing winches for the topping lifts.

(1) Advantages. Topping or lowering can be accomplished without lengthening or shortening the guys. It has greater spotting ability, insures reduction of port time, has greater safety than conventional burtoning systems, and has push button control over topping lifts.

(2) Disadvantages. It has greater initial and maintenance costs due to the need for vang posts and topping lift winches. These disadvantages are minor.

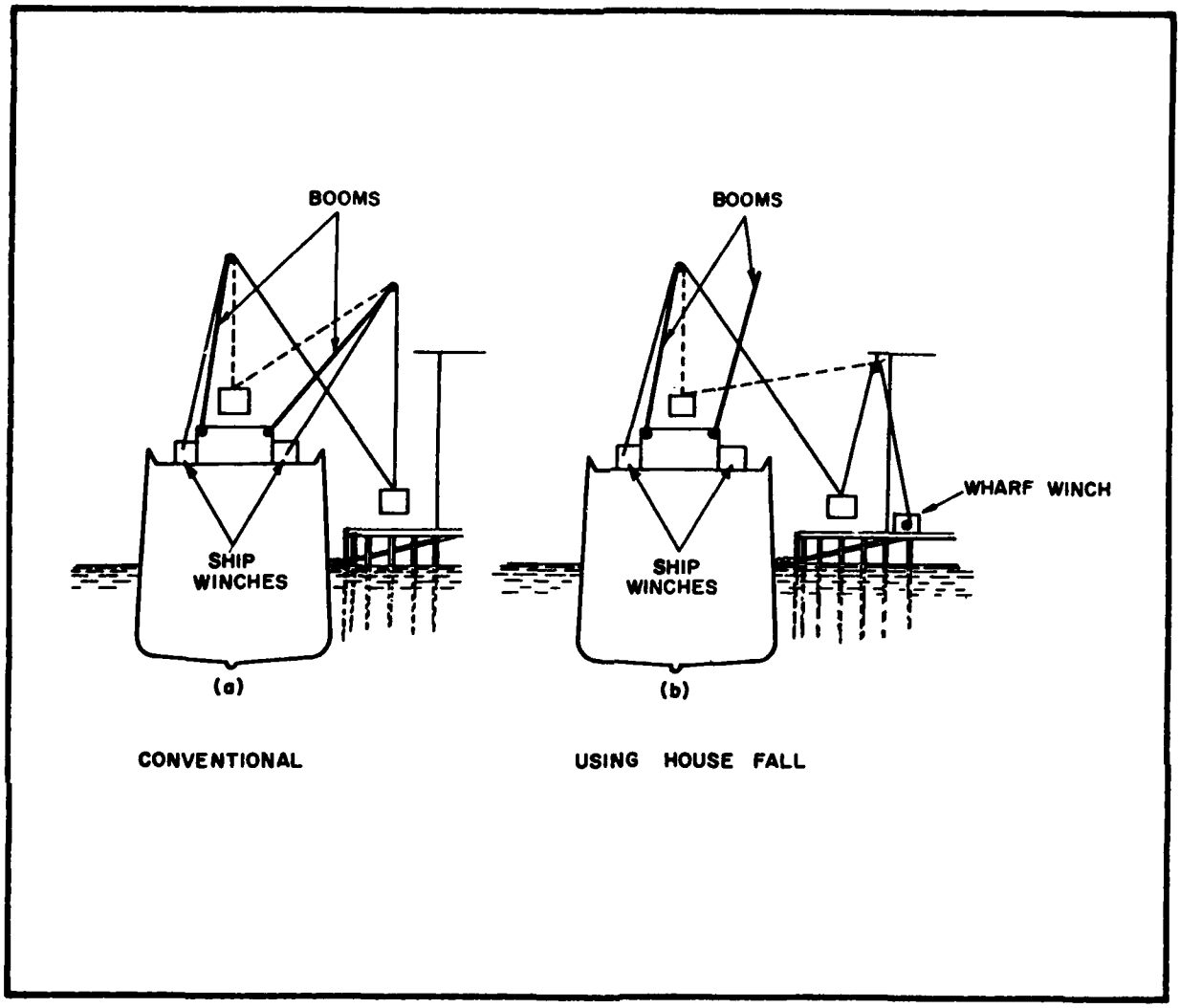


FIGURE 1
Burtoning System

c. Ebel Rig. This rig is similar to the Farrel Rig, but employs winches for both guying and topping. Vang posts are not used.

(1) Advantages. Loads up to maximum boom capacities can be handled if doubling-up blocks are properly employed. Guying and topping are accomplished entirely with push-button control. If winches are provided with "joy stick" operated master switches, both motions can be controlled by one hand. Other advantages include greater spotting ability, increased safety, reduction of port time, and improvement in deck housekeeping.

(2) Disadvantages. Not significant.

d. Jumbo Boom. In general, all U.S. Cargo ships have one or more jumbo (heavy lift) booms located at strategic hatches on the vessel. These booms usually are stepped in a pedestal mounted along the centerline of the vessel. When not in use, they are kept collared aloft.

(1) Advantages. There is greater "over side" reach than with conventional burtoning gear, plus high capacity. When backstays are used, capacities up to 60 tons or more are common.

(2) Disadvantages. A greater number of personnel is required to operate the system. Other disadvantages include slow operation, boom must be used as a swinging boom (slewing), readying gear from secured position is time consuming, limited maximum capacity, dangerous (when lowering heavy weights), and additional space is required tc stow auxiliary gear when not in use.

e. Shipboard Crane. The shipboard crane is another means of handling cargo with ship's gear. It has been found, in certain trades, to be faster than the boom mast/kingpost rigs. (Also, see Marine Cargo Operations.)

f. Siporter. The Siporter is a specialized means of handling cargo limited in quantity and of limited types. It consists of a set of booms (laterally slid into position) which extend out from the vessel's side just above the sideport. The booms support trolleys and hoisting blocks. When not in use, the booms are housed within vessel space. (See Marine Cargo Operations for additional information.)

g. House Fall. Certain piers (particularly those having narrow aprons and/or two-deck levels) are equipped with cargo masts which may be used in combination with the vessel's regular cargo handling gear. The usual method is to rig the ship's off-shore boom and winch to manipulate the up-and-down fall, and the cargo mast and dock winch to manipulate the burtoning fall. The latter being referred to as the house fall. (See Figure 1.)

(1) Advantages. These include increased over-the-side reach, sometimes being able to spot laterally the entire width of the pier apron, increased height that cargo can be worked by regular burtoning gear (ability to work second deck levels), and since the on-shore boom is not employed, the danger of this boom coming in contact with the pier terminal is eliminated.

(2) Disadvantages. The assembly and disassembly are time consuming.

2. SHORE-BASED EQUIPMENT. Types of shore-based equipment are indicated below. The amount and type of equipment required will vary according to the volume of cargo handled. For characteristics and selection factors for cranes, see DM-38.

a. Tracked Cranes. These cranes include rotating and non-rotating types which travel along a pier or wharf on tracks. Portal, tower, and locomotive cranes pick and deposit cargo by vertical lifting and lowering of the hooks and rotation of the boom. Some portal tower cranes employ a level luffing feature. Gantry, semi-gantry, and cantilever gantry cranes utilize vertical movement of the hooks and horizontal translation of the hook by means of a trolley.

(1) Advantages. Loads may be picked up or lowered at any loading point on the ship and deposited or picked up anywhere on the pier or wharf within the reach of the crane's boom or trolley. The crane can service heights above the decks of the ship not ordinarily reached by the ship's gear. In the case of heavy-lift cranes, maximum capacities often exceed those of the ship's jumbo booms. These cranes can be fitted with various attachments such as clamshells or grab buckets for handling bulk cargoes.

(2) Disadvantages. Initial high cost and mobility is limited to the area covered by the tracks.

b. Mobile Cranes. This category includes rubber-tired truck cranes and crawler cranes. Portal type cranes have been adapted to operate on rubber tires in lieu of steel-wheeled assemblies for running on tracks. The normal lifting capacity range generally used at ports is between 50 and 140 tons. Heavier capacity models also are available. The mobile truck crane is the prime mover of heavy cargo and repair parts for most naval vessels (See DM-25.1 for capacities, reaches, and imposed loads on piers and wharves). Mobile cranes have the advantage that they have virtually unlimited coverage on areas that are capable of supporting their loadings.

c. Container Cranes and Related Equipment. Most container vessels do not have shipboard cranes to handle containers, and on-shore container cranes will usually be a requirement. The most common type is the tracked gantry crane designed specifically for

container handling. Such cranes, which generally constitute a permanent installation, ride on fixed rails and can readily be spotted at any required lift location along the pier or wharf. They normally are available in lifting capacities ranging from 30 to 50 tons. Some cranes are capable of lifting substantially more weight. Normally, one or more cranes working will unload and load a containership with a normal cycle time of 3 to 4 minutes or 15 to 20 containers an hour per crane. Two cranes can unload an average size container ship in 18 to 20 hours. Container cranes may be fitted with various attachments, such as clamshells or grab buckets for handling bulk cargo, and hooks for breakbulk cargo. Other types of cranes also are used in container handling between vessels and shore. Typical examples are truck or crawler type mobile cranes fitted with container lifting spreaders. Such cranes are generally used on conventional piers and wharves which have not been equipped with container cranes. Figure 2 is a graphic summary of container handling systems. For details regarding container cranes, design criteria for containerized wharves and piers, and other related transfer equipment, refer to DM-25.1. Typical outside container dimensions appear in Table 1.

d. Conveyors. Conveyors are employed for handling bulk or relatively small packaged goods, but their limited maximum lifting capacity restricts their usage to relatively light cargoes. There are various accessory attachments and equipment which are selected for a specific cargo transfer that increases the efficiency of the handling operation. There is a wide variety of conveyors, including gravity, power, and airdriven types that move cargo over a fixed inclined or horizontal route.

(1) Skids and Chutes. In spiral chutes, packages move by force of gravity, and, under the action of centrifugal force, tend to move to the outside of the spiral. A disadvantage is that cargo bundles moved from a deck on to a sloping runway reach a point where they topple over. This can cause tall packages to fall forward. Skids and chutes are capable of handling a wide range of articles. Spiral chutes require no power, entail low maintenance costs, make economical use of space, and permit selective discharge of cargo at different elevations.

(2) Roller Conveyor. This device requires a pitch ranging from 3 to 7 percent grade to permit free rolling. The elevation changes are usually 5 to 10 feet per stage. Roller and wheel conveyors are relatively inexpensive and light compared to other devices. Manually-loaded package conveyors are limited to articles which one person can carry unaided (up to 100 pounds). Roller conveyors with capacities as high as 10 tons are available. The speed of individual rollers is usually about 250 revolutions per minute.

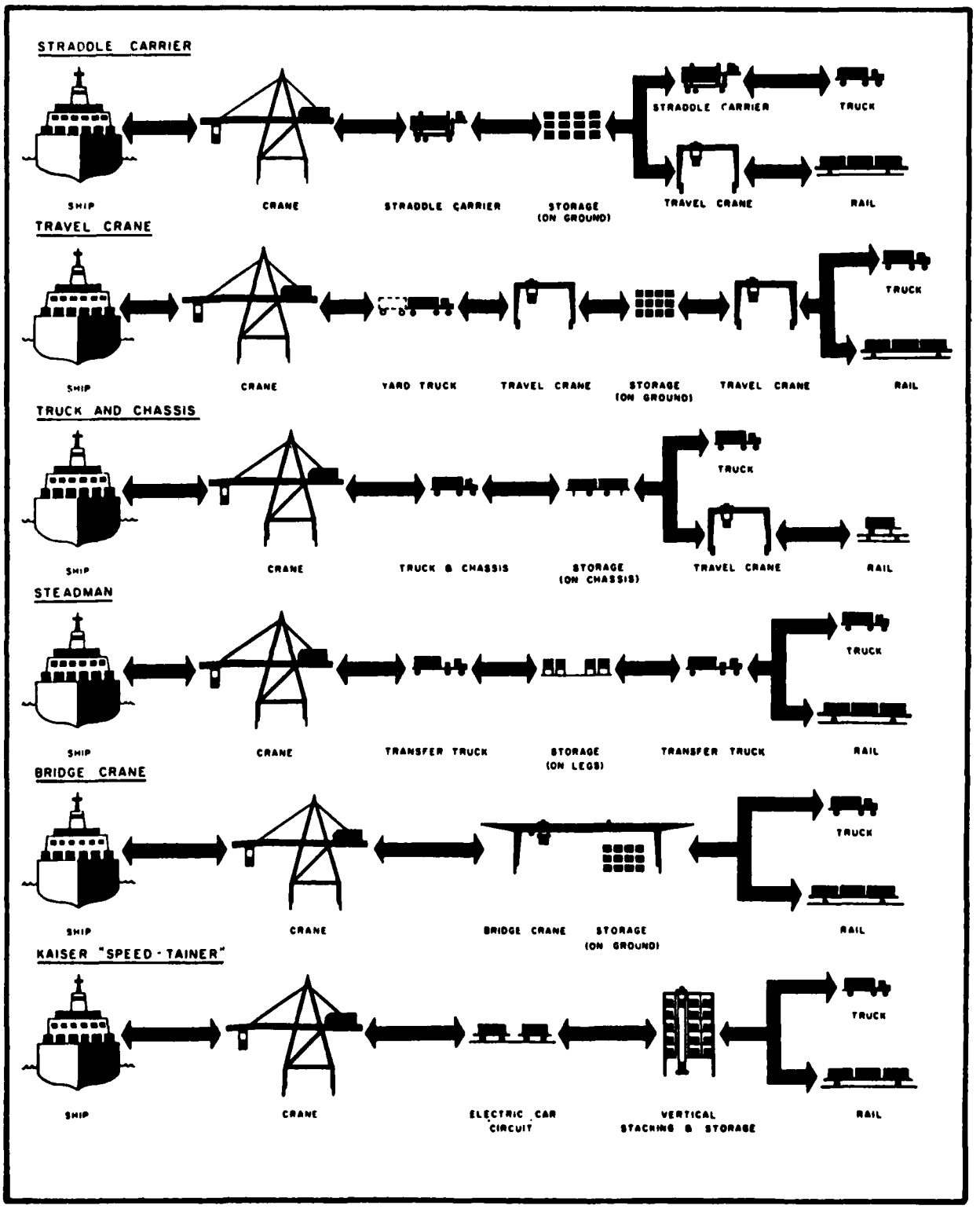


FIGURE 2
Graphic Summary of Container Handling Systems

TABLE I

OUTSIDE CONTAINER DIMENSIONS (1)

Container Designations	Military Terminology	Reference Size	Dimensions Length ft. in.	Width ft. in.	Height ft. in.	Maximum Gross Weight (Pounds)
1A		40-Footer	40	8	8	67,200
1B		30-Footer	29 - 11 1/4	8	8	56,000
1C	MILVAN	20-Footer	19 - 10 1/2	8	8	44,800
1D		10-Footer	9 - 9 3/4	8	8	22,400
1E	TRICON	---	6 - 5 1/2	8	8	15,700
1F	QUADCON	---	4 - 9 1/2	8	8	11,200
		24-Footer (2)	24	8	8 - 6 1/2	56,000
		35-Footer (2)	35	8	8 - 6	78,400
		CONEX (3)	6 - 3	8 - 9	6 -10 1/2	8,960

(1) Source: ISO 668 - 1976(E)

(2) These containers are obsolete, used only by three U.S. shippers and will not be permitted after January 1982.

(3) These containers are obsolete, have not been manufactured since early 1950 and will soon be extinct.

NOTE: Marine containers are now non-standard and will be phased out as rapidly as possible.

(3) Belt Conveyor. Many articles moved over a fixed route are carried on some form of powered, endless belt. In general, articles that can be transported on wheels or rollers will ride well on a belt. Standardized conveyor elements for particular requirements and units which can be rearranged or added if there are changes in operating conditions are readily available manufactured items. Few material handling operations require more careful measuring than that needed in floor-to-floor conveyor-line planning.

(4) Chain Conveyor. This device pulls or pushes cargo by direct contact. The entire length of the endless chain is actuated by a single source of power. Typical load ranges are between 75 and 600 pounds and typical speed is 30 feet per minute. Compared to belt conveyors, drag chain conveyors permit greater flexibility in the path of travel and are relatively simple to operate.

(5) Screw Conveyor. This device consists of a spiral member that winds around a circular shaft. Material is advanced by the action of the helical screw as it turns. It is a relatively inexpensive means of conveying pulverized or granular materials. In standard lengths, sections are coupled together.

(6) Pneumatic Tubes. These devices (pressure and suction types) are employed to convey light, free-flowing materials by means of moving columns of air. These tubes have been used for handling such items as grain and powdered substances.

3. SPECIAL EQUIPMENT. The devices described below are used to lift and move loads through the air along fixed paths and over limited areas.

a. Aerial Tramway. Aerial tramways transport materials and passengers from loading point to discharge point by means of overhead steel cables and ropes supported by one or more spans. Movement is intermittent over a fixed path. Effectiveness depends on the types of load handled.

b. Aerial Ropeways. Aerial ropeways may be employed where ships must transfer relatively light-weight cargo at open roadsteads. (See Figure 3.) They have also been used with advantage, during and after wars, in harbors where the piers and wharves have been destroyed through enemy action.

(1) Advantages. They may be adapted to a wide range of topographical conditions. Vessels anchor and moor to buoys off the ropeway terminal.

(2) Disadvantages. Inability to handle heavy loads. Assembly and disassembly are time consuming.

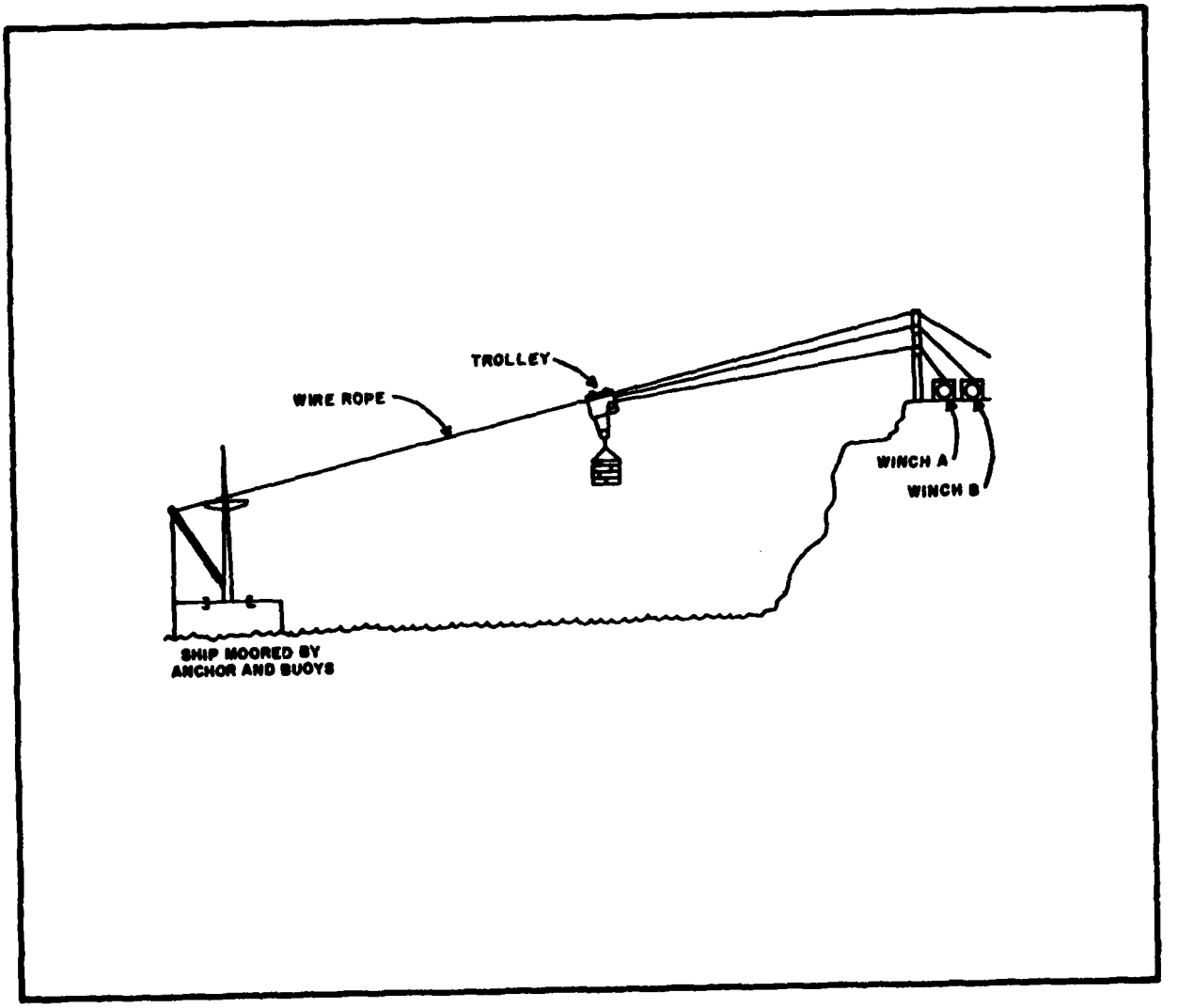


FIGURE 3
Aerial Ropeway

c. Over-the-Beach Highline Transfer. This device is a tensioned highline supporting a self-propelled trolley which runs from an offshore platform to an onshore terminal point. Loads are transferred from cargo ships to the platform and thence via highline to the beach. The self-propelled trolley can travel approximately 1,300 feet per minute along the highline.

d. Helicopters. Used to unload containers and other large pieces.

e. Lighter Than Air Devices. Controlled balloons used to unload containers and other large pieces.

f. Hydrofoils. Used to transport light cargo loads.

4. FLOATING EQUIPMENT.

a. Floating Cranes. There are barge-mounted cranes (some self-propelled) serving a wide variety of uses. Lifting capacities range from a few tons to 500 tons and more.

(1) Advantages. High capacity and elimination of "breaking out" the ship's jumbo boom for heavy lifts.

(2) Disadvantages. High cost of renting the equipment, which may not be readily available.

b. Pontoon Causeway. This device provides the final bridge from ship tc shore. When used in conjunction with LST's, it provides a simple, rapid, and effective means of unloading. It is deficient in severe tidal ranges and extensive mud flats. (For further details, see Pontoon Gear Handbook, P-401. See References.)

c. Bowramp Causeway. This is used successfully by LST's with bowramps for direct vessel to beach transfer of vehicles and material.

d. Pontoon Wharf. This type of cargo receiver is made of two pontoon bridge sections extending from shore abutments and connected to a floating barge section. The pontoons, consisting of steel-plate buoyant boxes, are of the Navy Lightered Pontoon type. When used with other pontoons, they form a floating wharf. Many configurations are possible. The pontoons and barge are held in place by spud moorings (loop guides and piles) or, alternatively, by a system of bottom anchors and lines. For further details, see DM-25.1 and Pontoon Gear Handbook, P-401.

e. Self Propelled Causeway. Pontoons with power are carried by the vessel, allowing it to operate its own ferry and provide ship-to-shore transfer. The cargo can either be rolled-on/rolled-off or lifted-on/lifted-off. A string of causeways can safely

transmit surf zones and flat beach gradients. With the addition of a winch and A frame the self-propelled causeway section is transformed into a side loadable tug. Each standard causeway section can carry a load of 105 tons of cargo with a resulting draft of 4 feet. For further details, see Container Offloading and Transfer System (COTS). (See References.)

f. Elevated Causeway. Pontoon module sections are joined to create an elevated causeway. This eliminates surf-induced motion and breakup and provides a solid platform for a container handling crane to lift containers from landing craft and barges. The system is derived from LST delivered causeways. Pontoons can be elevated in 5 foot to 7 foot surf conditions at an overall rate of 2 hours per section. It eliminates the slow transportability of the DeLong pier (see paragraph h below) and the linking of the DeLong to the shore. For further details, see COTS.

g. BARC. This is the U.S. Army Barge Amphibious Resupply Cargo (BARC) vehicle. It is 62 feet long, 27 feet wide, and 16 feet high, and has a normal pay load of 60 tons. It may be used in cargo handling only when beach conditions are most favorable.

h. Portable Piers (Spud Barge). These are floating barges which can be brought to the site and rapidly installed to form a fixed pier for cargo offloading. They jack themselves out of the water by means of large cylindrical piles. One disadvantage is the slow speed of towing to the site. An example is the DeLong pier which has been widely used in over-the-beach operations.

Section 3. BULK CARGO FACILITIES

1. BULK CARGOES. Bulk cargoes are frequently stored in piles on the ground where they are exposed to the elements. Characteristics of the materials must be considered when planning for stockpiling. Dock or upland areas must be adequate to accommodate such stockpiles, which may be 60 to 80 feet high for ore and 20 to 30 feet high for coal.

a. Elevated Storage. Bins, bunkers, silos, and sheds may be utilized when land areas near the waterfront are inadequate to provide sufficient ground space for open storage or where the commodity must be stored under cover.

b. Coal Handling Facilities. The tilting system, unloading bridges, and towers normally used in coal handling are listed below.

(1) Tilting System. Coal loading is usually accomplished by tilting a car's load into a hopper and discharging it by gravity into the vessel.

(2) Unloading Bridges. These commonly used bridges span the coal storage pile and cantilever over the vessel. Trolley grab buckets are provided for recovering coal from the hold and dumping it into the stockpile or into hopper cars.

(3) Unloading Towers. Coal is recovered from the hold by the use of grab buckets and dumped into hoppers in the towers. It is then conveyed by gravity to railroad cars or to a conveyor linked to the stockpile.

c. Oil Terminals. Equipment requirements are limited to storage tanks, hoses, hose-handling facilities (such as hose towers and fuel arms) and oil spill containment and cleanup equipment.

Section 4. OTHER TRANSFER SYSTEMS AND SCHEMES

1. LASH SYSTEM. This is a system whereby ocean going motherships transport cargo carrying barges of uniform dimensions. The barges are lifted on or off the mothership at the stern by a specially designed heavy lift traveling crane which is an integral part of the ship's equipment. The barges are towed between the mothership and shoreside facilities.

2. SEABEE SYSTEM. This system also consists of motherships transporting cargo barges of uniform sizes. Barges are carried two abreast on three levels. The barges are moved both fore and aft on deck by a powered transporter. Access from the water to each deck level is accomplished at the stern where a 2,000-ton capacity elevator is provided to handle the barges vertically. The elevator can handle two fully loaded barges simultaneously. Overhead clearance below deck is 18 feet.

3. LIGHTER SYSTEM. Cargoes are transferred by ship's gear from vessel to lighter. This system is generally used when vessels are moored offshore or in harbors or where cargoes are brought to a berth by water rather than land transport. There is a wide range of lighter sizes and capacities.

4. ROLL-ON/ROLL-OFF. Packaged cargo units (containers, trailers or freight cars) as well as a wide variety of equipment and other items capable of wheeled or tracked movement are rolled on or off vessels especially constructed for this purpose. Where permanent piers or wharves are not available, floating platforms and ramps can provide for interface between roll-on/roll-off vessels and pontoon causeways. Cargo can be rapidly loaded and unloaded by such vessels. This system is gaining increasing use in ocean transport, due principally to its capability of accommodating efficiently virtually all types of lading that can be moved on wheels. These include high and wide, heavy lift and out-of-gauge cargoes which would require time consuming and complicated handling on other vessels types.

a. Military Roll-On/Roll-Off Vessel Requirements. Military support vessels such as the newer LSTS are equipped with in-line bow and/or stern ramps. For LST bow ramp configuration and vessel characteristics, see USS Newport - LST 1179 Tank Landing Ship Booklet of General Plans NAVSHIPS No. LST 1179-845-2497341. Such vessels when along side piers or wharves often combine lift-on/lift-off operations using shore cranes with roll-on/roll-off activities. When berthed at piers or wharves, these vessels require a protruding shore ramp to enable them to interface with the pier or wharf and load or discharge roll-on/roll-off cargo. Ramp configuration and characteristic requirements vary from one support vessel type to another. Particular requirements of these vessels must be taken into account in the design of ramps to ensure effective roll-on/roll-off cargo operations.

b. Commercial Roll-On/Roll-Off Vessel Requirements. Some roll-on/roll-off ships, primarily European vessels, are self-sustaining requiring only a stable platform to which their ramps can be lowered for transfer of cargo. Such vessels range in size from shallow draft coastal types to long-range ships of greater than 30,000 DWT. While stern ramps predominate, some designs incorporate bow and side ramps. An increasing number of the newer vessels have quarter ramps or slewing ramps which facilitate the vessel's capability to adapt to a wide variety of berthing conditions. Roll-on/roll-off vessels having quarter or slewing ramps can berth alongside most conventional cargo piers with no special adaptation needed to the facilities, so that as long as there is sufficient apron width and pier deck loading capacity to permit the ramp to be landed and roll-on/roll-off cargo to be moved on and off the vessel. Both quarter and slewing type ramps are designed to hinge out at an angle from the vessel to the pier when in the lowered cargo handling position. In the case of roll-on/roll-off vessels having only in-line stern or bow ramps some form of protruding ramp or platform is necessary at conventional piers or wharves. Criteria for standardization of ramp configurations is contained in Report of the IAPH Sub-Committee on Standardization of RO/RO Ramps and Report from ICHCA on RO/RO Ramp Standardization. (See References.) It should be anticipated that commercial roll-on/roll-off vessels may be chartered to transport amphibious follow-on and resupply cargo. In this connection, planning should be done for authorized new pier construction or major pier modification at the ports that are now or might become emergency ports of embarkation as listed in Table 2.

c. Additional Information. For further details see Container Offloading and Transfer System (COTS) RO/RO Ship Interface. (See References).

TABLE 2

NAVY AND MARINE CORPS PORTS OF EMBARKATION FOR AMPHIBIOUS OPERATIONS

Facility	Closest Port		Commercial/Military Alternate Port	
	Location	Distance-Mi	Location	Distance-Mi
CONSTRUCTION BATTALION CENTERS				
NCBC--Gulfport, MS	Gulfport		New Orleans, LA	90
			Mobile, AL	75
NCBC--Davisville, RI	Narragansett Bay		Providence, RI	20
NCBC--Port Hueneme, CA	Port Hueneme		Long Beach, CA	80
			Los Angeles, CA	80
			Coronado/San Diego, CA	180
MARINE CORPS BASES				
Camp Lejeune, NC	Morehead City, NC	35	Little Creek/Portsmouth/ Norfolk, VA	210
		35		
Camp Pendleton, CA	Coronado/San Diego, CA	40	Los Angeles, CA	75
			Long Beach, CA	75
			Port Hueneme, CA	140
MARINE CORPS AIR STATIONS				
Cherry Point, NC	Morehead City, NC	15	Little Creek/Portsmouth/ Norfolk, VA	190
El Toro, CA	Long Beach, CA	40	North Island/San Diego, CA	85
			Port Hueneme, CA	100

Source: CEL estimates based on NAVSO P-2471, Official Table of Distances, and Rand McNally Road Atlas of U.S. - 1977

5. CRANE ON DECK (COD). This principle consists of placing a mobile crane on deck, and is an expeditious way of making the vessel self-sustaining when conventional gantries or other cranes are unavailable. For further information, see COTS.

6. MONORAIL WHARF. This system will permit monorail cars carrying 10-ton loads on each trip to discharge cargo from three to five ships simultaneously at a rate of approximately 600 tons per hour. There are three major system elements: ship mooring facilities, monorail ship-to-shore transport facilities, and shore facilities. Ships to be loaded or unloaded are moored alongside suitable dolphins (placed to act as fenders protecting the monorail structure and to hold the ship in position). Under suitable weather conditions, ships may be moored in position without dolphins if proper use of buoys and anchors is made. Mooring platforms should be approximately 16 feet wide and 50 feet long, and should support 40 tons of cargo. Cargo handling is limited only by the ship's ability to place the cargo on the loading platforms.

7. TIP-OFF. Cargo is stowed on brackets on the side of the ship and arranged so that it can be released and tipped off into the water.

8. FLOAT-OFF. This principle is relatively simple. The ship, ballasting down, floats preloaded boats (LVT's, LCM's etc.), which proceed to the beach. Typical of this class of vessels are LSD's, LPD's and LPH's.

9. HULL PORTS. Hull ports are openings in the side of the ship which are normally equipped with water-tight doors. Hull ports offer a means of unloading directly from one level of the cargo space and reduce vertical cargo travel from the unloading level to the water line, landing craft, or pier.

Section 5. SHED TRANSFER EQUIPMENT

1. HAND TRUCKS. Hand trucks are used for movement of packages too heavy for manual handling or for increasing the unit load of small packages. There are two types of hand trucks: two-wheel trucks, suitable for loads up to 600 pounds, and four-wheel platform trucks.

2. MOTORIZED TRUCKS. Motorized trucks are usually used for cargo being transferred directly from vessel out of the pier complex. Use of tractor trailer combinations for towing platform trucks is common.

3. FORKLIFT TRUCKS. Forklift trucks are useful for handling cargo in the shed or on the pier or wharf. Recommended aisle widths are listed below:

Forklift Capacity (lb)	Aisle Width (feet)
2,000	10
4,000	12
6,000	14
8,000	18
10,000	20

For wheel loads and dimensions of forklifts, see DM-25.1. In addition, heavy duty forklifts weighing 40 to 45 tons with lifting capacities of 20 tons or more are frequently used in roll-on/roll-off cargo operations.

4. CONVEYORS. See Section 2.

5. STRADDLE CARRIERS. Straddle carriers (see Figure 4) are used for handling lumber, pipe, rails, steel shapes, containers, and similar materials. The carriers may also be adapted for lifting multiple-pallet loads. For wheel loads for a straddle carrier see DM-25.1.

6. CRANE TRUCKS. These are smaller types of mobile truck cranes and are used primarily in sheds. They are used also in narrow areas, where they are able to pick up net slings or pallet sling loads that are bulky and are of complex shapes.

7. OVERHEAD TRAVELING CRANES. Overhead traveling cranes are commonly used to handle cargo in transit sheds. These normally traverse one or more entire bays of the shed. (See DM-38 for criteria.)

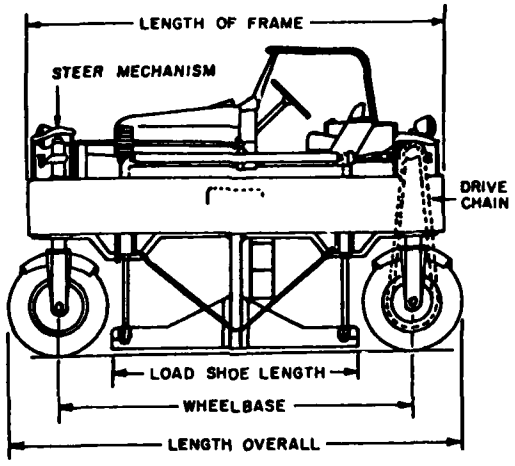
8. MONORAILS. Monorails keep the floor clear of vehicles and other obstructions. They are suitable where a single type cargo is to be conveyed over a fixed route. Monorails may extend beyond the sheds to the aprons. The principal disadvantage of a monorail system is its inflexibility.

9. ADDITIONAL SHED EQUIPMENT.

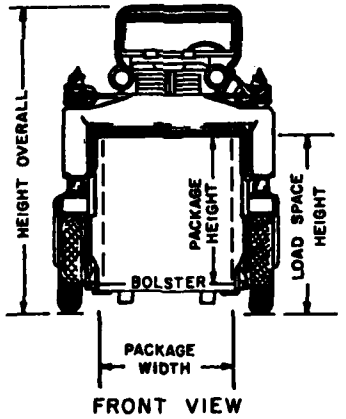
a. Pallets. Pallets are used to place unit loads and transfer them to another point. The standard pallet measures 40 x 48 inches and has access on all four sides to accommodate fork lift truck fingers.

b. Pallet Dolly. This is a dolly with two fixed and two swivel casters. A unit load is assembled on a pallet resting on the dolly and the dolly is pushed to its destination.

c. Hand Pallet Truck. Hand pallet trucks are utilized to pick-up, transport, and setdown pallets. They are usually hydraulically controlled.



SIDE VIEW



FRONT VIEW

FIGURE 4
Straddle Carrier

d. Hand Truck and Prys. These combine wheel and lever action in moving materials. Hand trucks and prys can be designed to carry cases, barrels, drums, kegs, bags, bales, and cylinders. Rubber-tire wheels are best for smooth operation.

e. Side Dump and End Dump. Trucks ride on or off tracks, generally pulled by a tractor. They are designed to handle dry materials when loading is done manually.

f. Mobile Dock Board. This is a lightweight ramp used to connect a tailgate of a truck to a loading platform so that cargo can easily be loaded from shed to truck.

g. Cargotainer. A wire-mesh container used to hold small parts for transport to various areas.

Section 6. ORDNANCE AND HAZARDOUS CARGO

1. FACILITIES AND HANDLING. Ammunition and explosives are handled at facilities specifically designated for that purpose. Such facilities usually consist of finger piers and wharves equipped to handle truck, rail, and lighter shipments in transfer to and from ocean-going vessels. Shipments entering the facilities are first checked and inspected at onshore receiving stations which may be separated from the pier by as much as two or more miles. Shipments are moved from the receiving stations to the pier and loaded directly aboard ship. Lighters are received alongside vessels at the pier and loading accomplished directly from lighter to vessel. Loading and transporter equipment at the facilities is electrically powered and must be equipped with explosion-proof motors. Shipments are loaded onto or discharged from vessels with electric shore-based cranes or with ship's gear. An example of an ammunition and explosives handling facility is the Navy pier at Earle, New Jersey. This deep water pier, which extends approximately two miles from shore into Sandy Hook Bay, is equipped for rail and truck movements and can handle breakbulk, unitized, and containerized shipments.

a. FAST System. Fast Automatic Shuttle Transfer (FAST) is a mechanized transfer system designed primarily for, but not limited to, transferring guided missiles from the hold of a supply ship to the magazine of a combatant ship. It combines high transfer rates (900 feet per minute) with maximum safety for personnel and missiles (either Terrier/Tartar, or Talos). The significant features of the system include mechanized handling from the hold, structural M-frame in lieu of boom/king post, highline tensioned by hydraulic rams, automatic, tensioned in-haul/out-haul winches, rig passed and tended by the sending ship, and sliding block for raising and lowering the load.

b. Specific Information. For specific information on ammunition and explosives handling and storage, refer to the sources listed below:

Source	Title
NAVSEASYSCOM	
OP-5	Ammunition and Explosives Ashore
OP-3221, Rev 1	Loading and Stowage of Military Ammunition and Explosives Aboard Breakbulk Merchant Ships
General Services Administration, Code of Federal Regulations (CFR) Title 46-Shipping	Transportation or Stowage of Explosives or Other Dangerous Articles or Substances, and Combustible Liquids on Board Vessels
Joint Nuclear Weapons Publications System, Special Weapons Ordnance Publication (SWOP)	
100-1	Supply Management of Nuclear Weapons Materiel
45-51 Series	Transportation of Nuclear Weapons Materiel

c. Definitive Drawings. The following drawings, contained in Definitive Designs for Naval Shore Facilities, NAVFAC P-272, shall be a part of these design criteria.

NAVFAC Drawing No.	Title
1041109	Primary Lightning Protection Design for Ordnance Handling Facilities - Crane on Pier and Wharf-Design Criteria
1041110	Primary Lightning Protection Design for Ordnance Handling Facilities - Crane on Wharf - Examples No. 1 & No. 2
1311353	Oil Spill Containment for Berthing Facilities

REFERENCES

NAVFACENGCOM Design Manuals and P-Publications

DM-25.1	Piers and Wharves
DM-38	Weight Handling Equipment and Service Craft
P-401	Pontoon Gear Handbook

Government agencies may obtain Design Manuals and P-Publications from the U.S. Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA. 19120. TWX: 710-670-1685, AUTOVON: 442-3321. The stock number is necessary for ordering these documents and should be requested from the NAVFACENGCOM Division in your area.

NON-Government organizations may obtain Design Manuals and P-Publications from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Container Offloading and Transfer System (COTS), NAVFAC, Assisting: NAVSEASYSCOM, Program Element: PE 63719N, August 1979.

Marine Cargo Operations, Saurbrier, Charles L., John Wiley and Sons, Inc., New York, N.Y.

Report of the IAPH Sub-Committee on Standardization of RO/RO Ramps, L. Arvidson, in Proceedings of the International Conference on Marine Transport, London, 21-22 June 1977, PP 137-145.

Report from ICHCA on RO/RO Ramp Standardization, B. Abbott, in Proceedings of the International Conference on Marine Transport, London, 21-22 June 1977, PP 147-148.

RO/RO Ship and Shore Ramp Characteristics - An ICHCA Survey, London 1978.

USS Newport - LST 1179 Tank Landing Ship Booklet of General Plans NAVSHIPS No. LST 1179-845-2497341.

NAVSEASYSCOM

OP-5	Ammunition and Explosives Ashore
OP-3221, Rev. 1	Loading and Stowage of Military Ammunition and Explosives Aboard Breakbulk Merchant Ships

General Services Administration, Code of Federal Regulations (CFR) Title 46 - Shipping.

Joint Nuclear Weapons Publication System, Special Weapons Ordnance Publication (SWOP)

100-1	Supply Management of Nuclear Weapons Materiel
45-51 Series	Transportation of Nuclear Weapons Materiel

NAVFAC P-272 - Definitive Designs for Naval Shore Facilities

Drawing No.	Title
1041109	Primary Lightning Protection Design for Ordnance & Handling Facilities - Crane on Pier and Wharf-Design Criteria
1041110	Primary Lightning Protection Design for Ordnance Handling Facilities - Crane on Wharf - Examples No. 1 & No. 2
1311353	Oil Spill Containment for Berthing Facilities

GLOSSARY

Blocks. A wooden or metal case enclosing one or more sheaves, and fitted with a hook, eye or strap by which it may be attached to an object and used to change the motion or direction of the object.

Draft. Depth of vessel hull below the waterline.

Fairlead. Pulley for change of direction or guide of a line.

Hatch. A deck opening over the cargo hold of a ship.

Kingpost. A short strong tubular mast that supports cargo booms.

Lighter. Small vessel used for transfer of cargo from ship to dock or vice versa, in shallow water harbors.

Lizard. A rope with a thimble or block spliced into one or both of the ends used as a fairlead in handling a ship's rigging.

Pier. A dock that is built from the shore out into the harbor and used for berthing and mooring vessels.

Ship's Boom. A long spar attached to the base of a mast or kingpost. Use as a derrick to handle cargo.

Vang Post. Posts holding vang ropes.

Vang Ropes. Either of 2 ropes extending from the peak of a boom to steady it when the boom is not cradled.

Wharf. A dock, oriented approximately parallel to shore and used for berthing or mooring vessels.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